



FAW

Variation of Isolation Resistance Caused by Water for HV Components and Related Safety Analysis

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The test of isolation resistance measurement for HV components being exposed to water

2

Risk of isolation failure for HV system

3

Conclusion

1. The test of isolation resistance measurement for HV components being exposed to water

Test objects



HV wire harness



HV wire harness



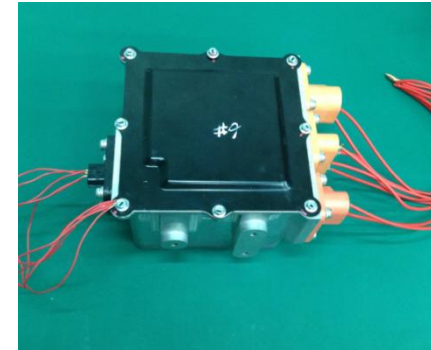
Service disconnect



Service disconnect



**On-board charger
integrated with DCDC**



PDU

1. The test of isolation resistance measurement for HV components being exposed to water

Test items

- ◆ HV wire harness and service disconnect were put into water and then their isolation resistance was measured.
- ◆ Water was put into the housing of On-board charger integrated with DCDC and PDU with different quantity for several times. Isolation resistance of the two HV components was measured after each injection of water and also measured at time of 24 hours and 48 hours after the first measurement of isolation failure.

Note: Each measurement of isolation resistance was done twice ,with the HV positive and negative electrode parallel connected and not connected .

1. The test of isolation resistance measurement for HV components being exposed to water

Test result

- ◆ For HV wire harness and service disconnect, isolation failure occurred after being exposed to water.(Isolation failure means isolation resistance $< 500\Omega/V$.)

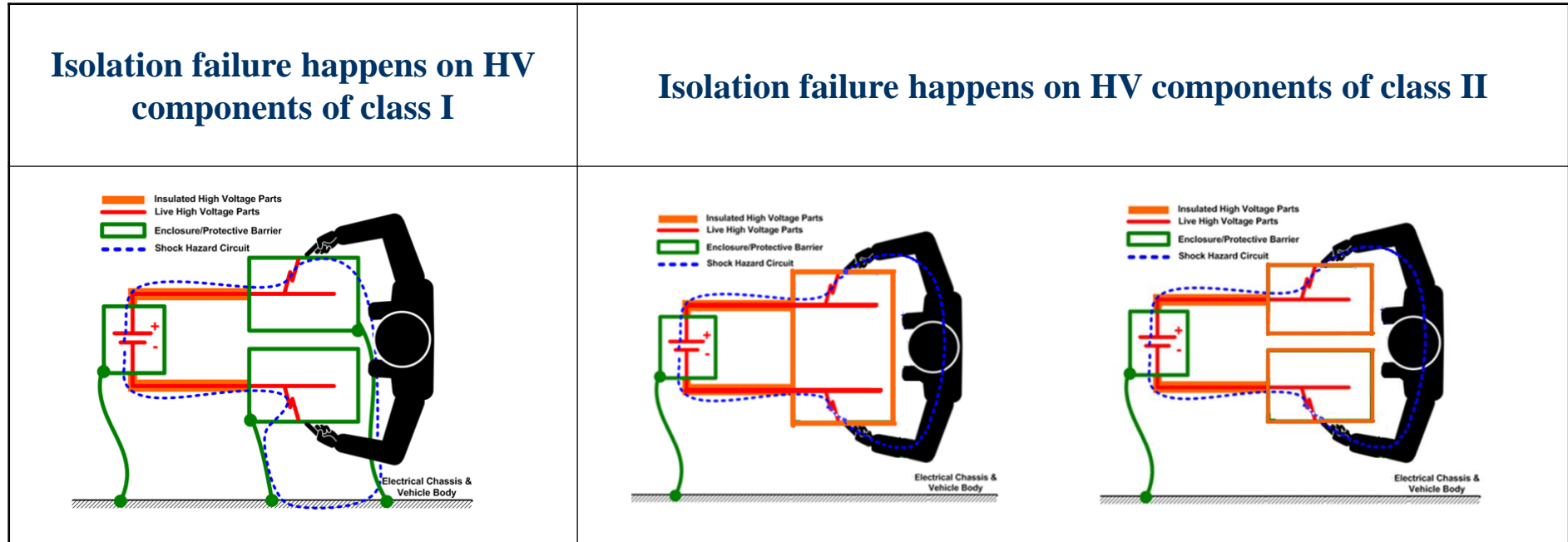
- ◆ For On-board charger integrated with DCDC and PDU:
 - Isolation fall and isolation failure occurred after water was put into their housing.(Isolation failure means isolation resistance $< 500\Omega/V$. Isolation fall means isolation resistance drops but still $> 500\Omega/V$.)

 - Isolation failure occurred at the time of 24 hours and 48 hours after the first measurement of isolation failure.

- ◆ Isolation failure of HV components had two conditions, isolation failure on both HV electrodes or only on HV positive/negative electrode .

2. Risk of isolation failure for HV system

Analysis of isolation failure condition for HV system



Class I(from ISO 6469-3-2001)

Equipment in which protection against direct contact is ensured by using basic insulation over live parts and connecting together the exposed conductive parts of this equipment using a protective conductor.

Class II(from ISO 6469-3-2001)

Equipment in which protection against direct contact is ensured by using double insulation or reinforced insulation.

2. Risk of isolation failure for HV system

Analysis of risk for isolation failure of HV system

the Class of HV component	the direct result of isolation failure	detail condition	risk	detection method of the risk
Class I(with potential equalization part)	A electric circuit completes with HV positive electrode, HV negative electrode and electric chassis. The current in this electric circuit $>2\text{mA}$	HV circuit is cut by fuse.	There is on risk.	
		HV circuit is not cut.	Long time of existence of the current may cause heat accumulation in certain part and even causes a fire.	Isolation resistance monitoring system
Class II(without potential equalization part)	A electric circuit completes with HV positive electrode and HV negative electrode.	Isolation failure happens to HV positive and HV negative in one HV component.	There is the risk of electric shock for persons.	
		Isolation failure happens to HV positive and HV negative in two HV components.		

◆ Isolation failure of HV system have the risk of causing fire and electric shock.

3. Conclusion

◆ By doing the test, it has been proved that there is the risk of isolation failure for HV components after being exposed to water. And it has been analyzed that isolation failure of HV system may cause fire and electric shock to persons .

➡ As a result, isolation resistance measurement should be performed after test of protection against water for electric vehicles.

About next work step :

The test procedure of protection against water is the key point of next work step , we suggest to use the test procedure in ISO 6469-3-2001 .Besides, we think the measurement of isolation resistance should be performed not only right after the test of protection against water, but also at the time of 24 hours after the first measurement.



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